

Development of the PIONEER 1000

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ABSTRACT

The PIONEER 1000 was developed to serve as a flagship model for the PIONEER series in the North American market for Side by Side vehicles, also known as recreational off-highway vehicles. Three-passenger and five-passenger types are made available, both applying a new 999 cm³ parallel-twin engine, the largest in the Side by Side market, and for the first time in the Side by Side market a dual clutch transmission. These are built with a common platform and have excellent versatility, function and durability deriving from the numerous technologies applied. It is a model that presents an enhanced appeal within Honda's multi-category PIONEER series that is popularly used for various purposes such as recreational activities and practical work.

1. Introduction

The history of Honda's off-road buggies began with All-Terrain Cycle (ATC) US90 of the 1970s, the world's first three-wheeled vehicle that a rider would straddle, later evolving into the four-wheeled all-terrain vehicles (ATV) that continue to grow in the North American market to this day. Honda also developed four-wheeled buggies (FL), in which a driver would sit on a seat with back support, beginning with the FL250 (ODSSEY 250), followed by the FL350R (ODSSEY 350R) and the FL400R (PILOT 400R), which were sold on the market until 1990. These ATCs, ATVs, and FLs were all single-rider models. Side by Sides, on the other hand, maintain the mobility and trail capability of ATVs while accommodating multiple passengers to enjoy activities such as hunting and trail driving; their increased cargo and towing capacities allow them also to be used for practical work on farms (Fig. 1). Due to these reasons, the Side by Side market has markedly grown since 2003, and it is still growing as of 2016. There is a wide range of models made available from various manufacturers, with passenger capacities of 2 to 6 and engines having displacements of 150-1000 cm³. Honda's inaugural Side by Side was the BIG RED 700, followed by the PIONEER series that consisted of the PIONEER 700 and the PIONEER 500, and the PIONEER 1000 that we are introducing in this article.

Generally large-capacity Side by Side vehicles are larger and prone to a loss of mobility and maneuverability. The PIONEER 1000 applied a technology that allows the rear seat to be folded and stowed for a more compact body. Coupling a high-power engine with the dual clutch transmission (DCT) and applying long-travel suspension

and large tires, we were able to create points of appeal that would enable the product to be the best in class. Hereafter we introduce the PIONEER 1000 (Fig. 2, Fig. 3, Table 1).



Fig. 1 Usage example of a Side by Side

* Motorcycle R&D Center

Table 1 Model variation and features

Features	3P STD	3P EPS	5P EPS	5P DLX
27 inch bias tire	○	○	○	
27 inch radial tire				○
Aluminum wheel				○
Electric power steering		○	○	○
Tilt steering		○	○	○
Color panel		○		○
Camouflage color		○		○
Manual shift mode		○	○	○
Self-leveling suspension			○	○
LED head light				○



Fig. 2 The PIONEER 1000-3



Fig. 3 The PIONEER 1000-5 DLX

2. Development Aim

PIONEER 1000 was developed under the concept of “King of Works Hard, Play Hard.” The Side by Side market offers models having multiple rows of seats (front and rear) for 4 to 6 passengers, allowing a group of people to enjoy recreational activities together such as trail riding. However, securing cargo space makes the wheelbase longer, enlarging the turning radius and thus impacting the handling that is useful in work such as patrolling on farms and transporting cargo. We utilized Honda’s own packaging technology to provide the model with the maneuverability of a two-passenger vehicle while accommodating a higher number of passengers. Another aim was the achievement of excellent

performance in driving power, trail drivability, ride comfort, quietness, low vibration levels, and workability such as towing and cargo capacities. Further, we aimed to make the model available at a reasonable price for customers by lowering product costs, achieved by using common base frame parts of the frame body, excluding the three-passenger rear bed components and five-passenger rear roll bar.

3. Engine and Powertrain

Based on the concept of the model being a flagship, the following were determined as its targets:

- A lightweight, compact engine with a low center of gravity that would provide both sufficient passenger space and ground clearance.
- High driving power that would allow the vehicle to easily climb a steep angled slope (estimated as having the steepest angle for use of a multi-category Side by Side), while fully loaded, at maximum towing capacity and the sub-transmission in the high range (Fig. 4).
- The acceleration and maximum speed of the vehicle was to become the highest level for the class.
- Transmission that achieves both the convenience of an automatic and a more direct drive feel.

In order to achieve these targets, the engine displacement was set to be 999 cm³, the largest for a Side by Side, the engine to be a liquid-cooled with overhead camshaft (OHC), 4 valves, and inline 2-cylinder system, and the transmission to be a DCT with a sub-transmission.

The key specifications are provided in Table 2.

3.1. Engine Packaging

3.1.1. Engine installation direction/position, axial positioning

From the perspective of mass concentration and weight reduction, the engine and transmission were integrated. The engine was to be located in the center of the vehicle from the perspective of the vehicle’s front-rear weight distribution and placed in the longitudinal direction,

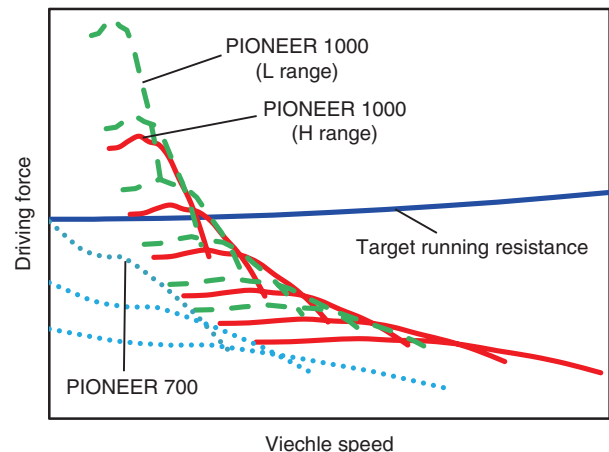


Fig. 4 Driving force diagram

Table 2 Engine specifications

Engine type	Liquid-cooled 4-stroke
Cylinder arrangement	Parallel
Number of cylinder	2
Crank angle	270 degree
Bore/Stroke	92 mm/75.2 mm
Displacement	999 cm ³
Compression ratio	10.0:1
Maximum power (Counter shaft)	50 kW/6000 r/min
Valve train	Unicam/4 valve
Lubrication	Dry-sump
Balancer	Single-shaft Primary-balancer
Transmission	6-speed DCT transmission + subtransmission

eliminating the need for a bevel gear (Fig. 5).

We achieved the targeted weight balance by placing the engine so it is partially under the front seat, with the cylinder head and the intake system towards the back of the front seat (Fig. 6).

3.1.2. Dry sump structure with a built-in oil tank in the engine

Many Side by Sides apply a dry sump to secure engine pressure stability in conditions such as steep uphill, downhill driving and traverse driving while keeping the engine height low. With this model, we applied a dry sump structure in which the oil tank is integrated in the engine to

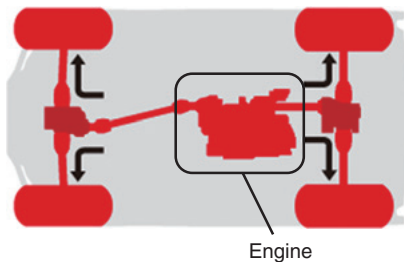


Fig. 5 Engine placement (plain view)

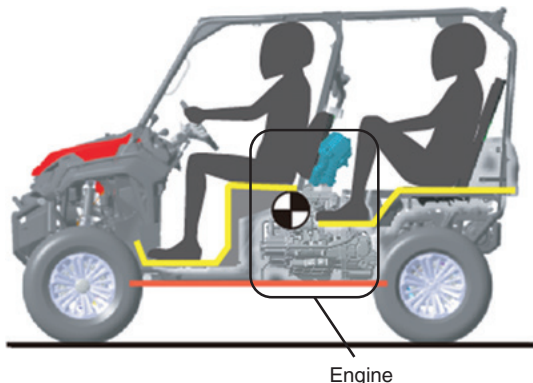


Fig. 6 Engine placement (cross-section)

take it further and reduce the number of parts (Fig. 7).

The oil pan was made flat to keep the overall engine height at 525 mm and the distance between the output shaft and engine bottom at 116 mm. This allows the vehicle to achieve the targeted ground clearance and passenger space, as well as lowering the center of gravity (Fig. 8). An oil tank was formed on the cover in the rear of the engine and integrated into the engine. No longer needing a separate oil tank and piping, this allowed for a reduction in the number of parts as well as a more concentrated mass.

3.1.3. Unicam valve train

The Unicam valve train system (Fig. 9) was applied to achieve reductions of the weight and size of the engine while enabling high power performance. With this, it was possible to reduce the weight by 800 grams and the size of the cylinder head compared to a general dual over-head camshaft (DOHC) mechanism, both of which contributed to securing adequate passenger space and a lower center of gravity.

3.1.4. Transmission

A DCT system was applied for the model to have the convenience, efficiency, and usability at low speeds of an

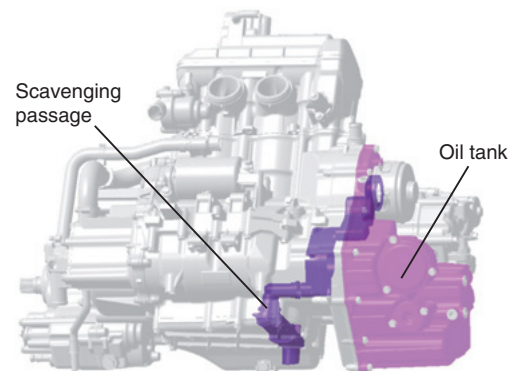


Fig. 7 Dry sump system

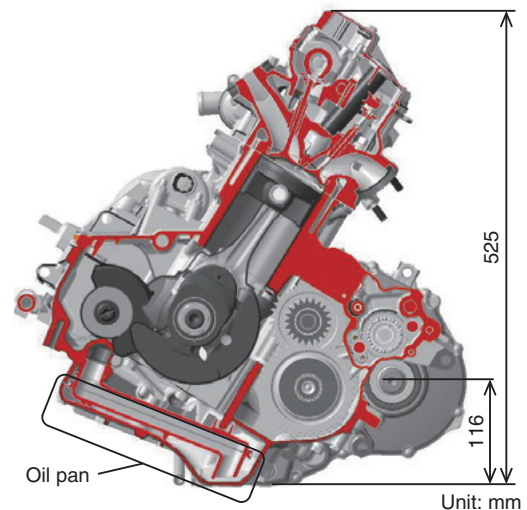


Fig. 8 Cross-section of the engine

automatic transmission (AT) system. As shown in Fig. 10, this DCT system is a carry-over from what is applied to basic structure of the NC 700 series⁽¹⁾ in the motorcycle category. Increasing the number of the discs and plates of each clutch from 3 to 4 provides enough clutch capacity required for recreational uses and utility work. The sub-transmission is positioned towards the lower stream of DCT's power transmission path, and has built-in gears for normal driving (high range), utility work (low range), and driving in reverse (reverse range). The sub-transmission also has a parking dog built in. The structure is a carry-over from Honda automobiles. Figure 11 shows that the parking dog is placed along the outer circumference of low range transmission dog to reduce the number of parts.

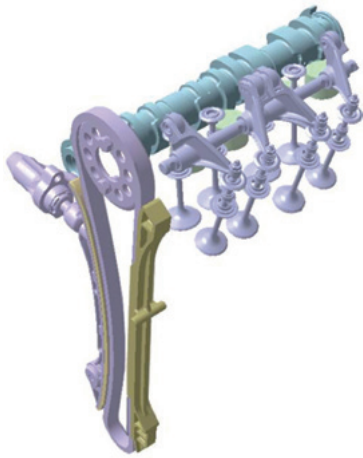


Fig. 9 Unicam valve train system

3.2. DCT Control

Hereafter, the control that was newly developed for use on Side by Sides is explained.

3.2.1. Vehicle start control of the clutch

The ECU receives various types of information from the vehicle, including information about clutch rotation, clutch oil pressure, vehicle speed, and throttle open angle. Based on the information received, the ECU calculates the necessary driving power for the road conditions and applied load in real time. By controlling the clutch oil pressure with such a mechanism, the vehicle take-off has been made smoother. With this particular model, because of the considerations needed for uphill/downhill driving and ease of heavy

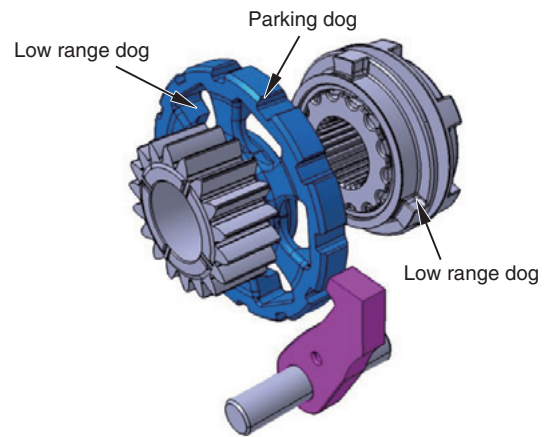


Fig. 11 Parking dog

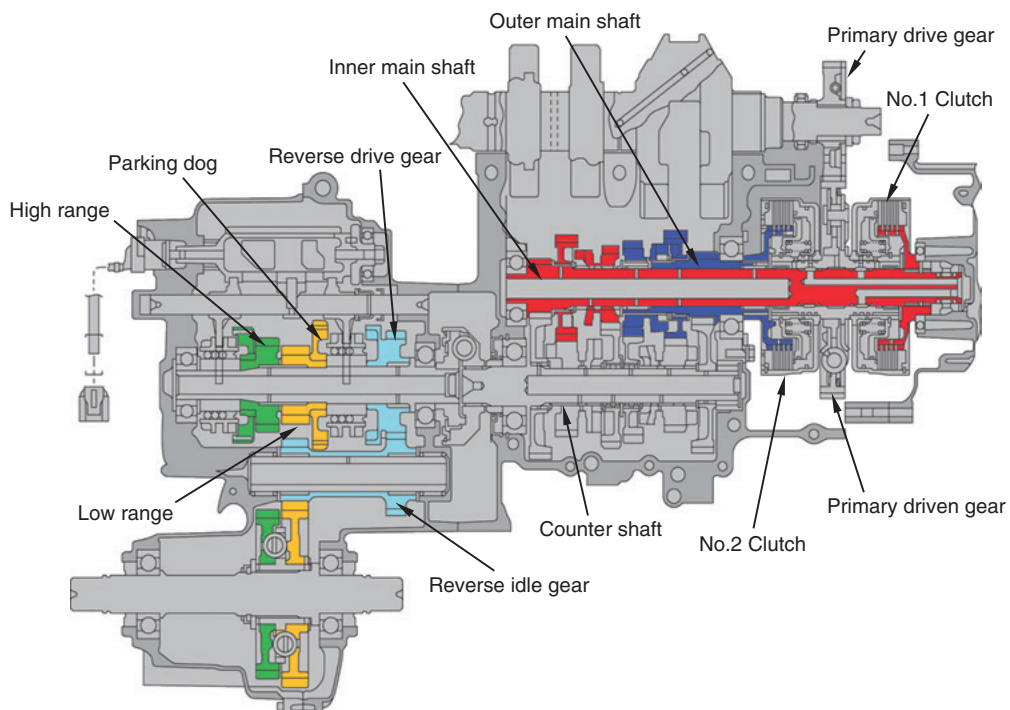


Fig. 10 Transmission layout

towing, smooth control is required at a very low speed range (3 km/h or below). To meet this need, we added a DCT-exclusive speed sensor on the engine, improving the sensing resolution by nearly 300%, to provide an improved and very smooth clutch control at very slow speeds (Fig. 12).

3.2.2. Clutch control when driving

When opening and closing the throttle, a typical transmission hesitates momentarily, causing a change in the driving power and affecting the vehicle behavior. To mitigate this effect, we added a control to lower the clutch oil pressure for a short moment (approximately 300 ms).

With Side by Sides, engine braking when driving down steep slopes is also important. Therefore, the clutch needs to be engaged during deceleration up until immediately before stopping. However, setting up a system in this manner would cause the engine to stall due to a delay in clutch disengagement in situations such as locked tires when braking immediately before stopping. The engine would also be prone to stalling due to engine locking when doing “hard braking” on slippery surfaces such as snow.

In order to prevent such engine stalls, we applied an algorithm that predicts tire locking by monitoring various rates of changes, in addition to clutch control using vehicle speed and engine speed information. This allows for the quicker sensing of a sudden deceleration, making it possible to swiftly disengage the clutch in situations where tires may lock up.

Another cause of clutch disengagement delay is the decrease of clutch oil pressure response in extreme low temperatures, a condition to which Side by Sides are often exposed. As a countermeasure for clutch disengagement delay, corrections by oil temperature were newly added on the control logic.

3.2.3. Shift timing control

In the AT mode, the shift timing setting was made with considerations for ease of use in recreational and practical

work scenarios. For those customers who wish to enjoy a sportier driving style, Sport mode is also available.

When the sub-transmission is in low range, the low-speed gears will be used more frequently. This allows for the model to have a characteristic of ease of use in lower speeds, such as towing heavy items. For the shift timing control logic, the latest motorcycle DCT know-how was applied for use in Side by Sides.

- Predictive cornering shift: Prevents unexpected upshifts when cornering.
- Deceleration adaptive shift-down control: The greater the deceleration amount, the greater the vehicle's shift-down speed is transferred, enhancing the effect of engine braking.
- Automatic map-switching control: The system learns the frequency of the driving load to optimize shift timing.

With regard to the driving style characteristics of off-road vehicles, such as carrying cargo and/or towing, uphill/downhill driving, and tail-sliding, we applied the DCT control technologies built for the TRX420 series ATV to provide drivers with optimal shift timing that respond to individual driving styles and the environment in which the vehicle is driven.

3.3. Powertrain Control System

3.3.1. DCT control system

The paddle shifter that we applied, which enables the driver to shift gears while holding the steering wheel, allowing for quick maneuvering in various driving conditions (Fig. 13). Excluding the three-passenger standard model.

For this particular model, much effort was put in to make it suitable for a flagship model. A detent mechanism was added to the paddle shift structure previously applied to PIONEER 500 to create a high-quality operational feel. Because of the nature of the product's use and the likely exposure to water and dust, the paddle shifter was robustly constructed to make it more durable and more stable in terms of operability.

Figure 14 shows a switch that was applied to switch between the AT and MT modes, which also allows the rider

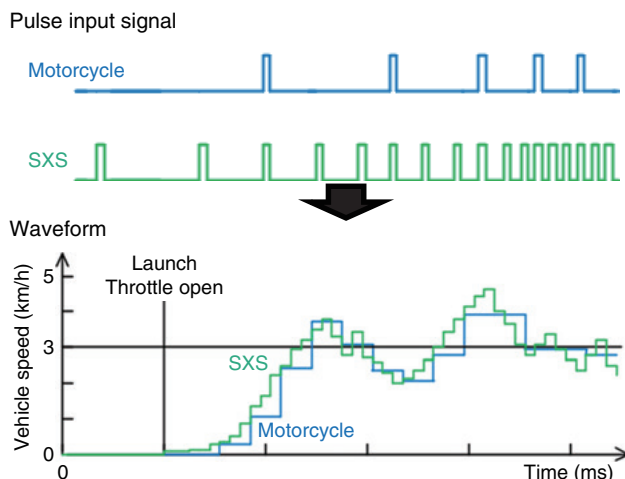


Fig. 12 DCT speed sensor

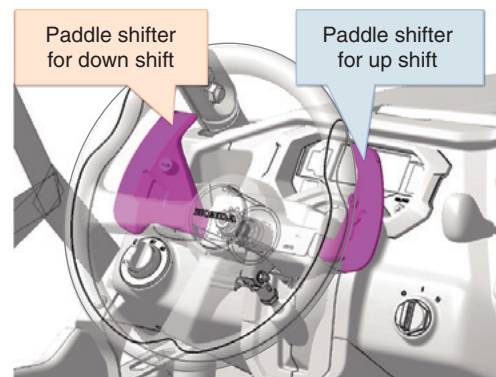


Fig. 13 Shift paddles

to switch to Sport mode within the AT mode.

When in the AT mode, the driver can select to choose the MT override mode by operating the paddle shifter. Using information such as throttle opening angle and vehicle driving speed, it smoothly returns from MT override mode to AT mode with the automatic return function at an appropriate timing. This makes it possible to drive comfortably even when in MT override mode.

3.3.2. Sub-transmission control system

The single lever sub-transmission shift capability that was explained earlier (Fig. 15).

Operating the lever drives the spindle shaft joined to the sub-transmission, so it can switch among parking, reverse, neutral, high range and low range positions.

With this model, Figure 16 shows the lost motion is structured with springs on the sides of the shift fork to improve the feel of shift lever operation.

3.3.3. Drive mode switching mechanism

The driver can select the desired drive mode to meet usability and road conditions from four drive modes using a mechanical mode select lever (Fig. 17).

The four drive modes are: 2WD, 4WD, 4WD Diff Lock, and Turf, which is designed to avoid damage to lawns and pasture grass when turning the vehicle with the rotation difference between inside wheel and outside actuating of front/rear differential gear. The actuation condition of the

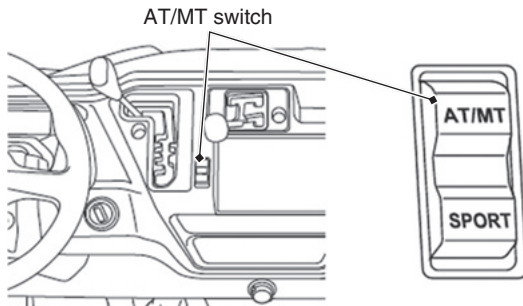


Fig. 14 AT/MT switch



Fig. 15 Shift lever

front/rear differential is shown in Fig. 18. For switching between 2-wheel drive, 4-wheel drive and differential lock, a simple, light and compact mechanical structure (Figs. 19 and 20) was applied.

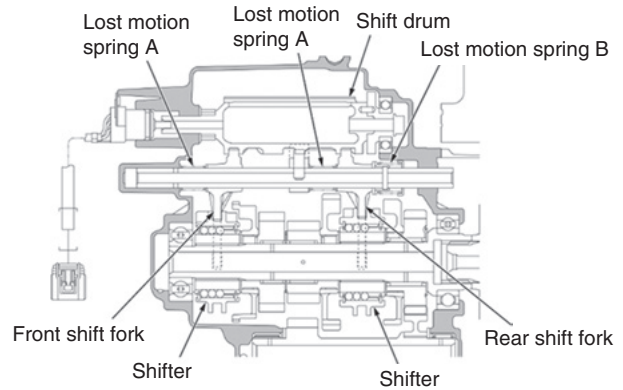


Fig. 16 Lost motion structure



Fig. 17 Drive mode select lever

	Front	Rear	Drive mode indicator
Turf	○	○	
2WD	○	●	
4WD	○	●	
4WD DIFF LOCK	●	●	

○ : Differential ● : Differential lock

Fig. 18 Drive mode

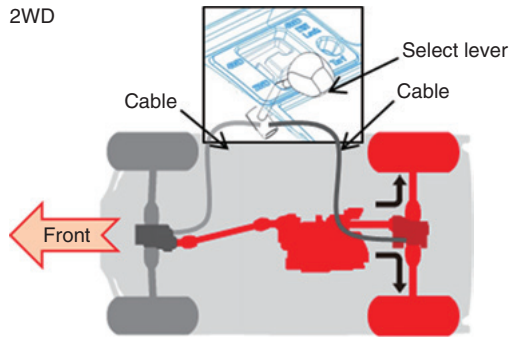


Fig. 19 2WD mode

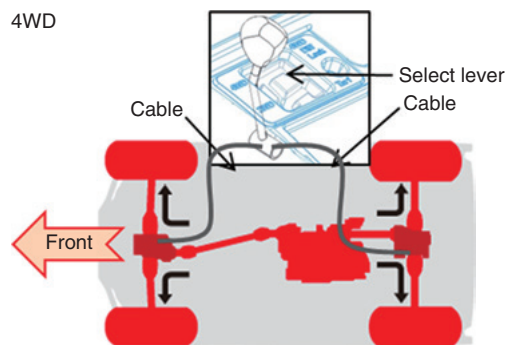


Fig. 20 4WD mode

4. Vehicle Body

4.1. Vehicle Body Packaging

As mentioned in the development aim, securing cargo space necessary for practical work and two rows of seating makes the wheel base long and turning radius greater, making the vehicle unable to have the level of mobility and maneuverability of an ATV. For this model, based on the commonization of the platform between the three- and five-passenger models, we studied how we could make the vehicle body compact, with a shorter wheelbase and narrower width, while still securing an adequate amount of comfortable passenger space necessary for a flagship model.

In order to make the body compact with minimized overall length and a narrower vehicle width, the following three methods were applied.

- Intake parts placed above the engine
- Application of the QuickFlip® seat for the rear row
- Application of a three-passenger seat in front having a new structure

By doing so, we were able to create a complete vehicle with comfortable passenger space with a short wheelbase of 2036 mm and excellent maneuverability, with a minimum turning radius of 4.2 m that is top-in-class level (Fig. 21, 22).

4.1.1. Positions of the engine and air cleaner

For the engine, we minimized the distance between the output shaft and the engine bottom, as well as lowering the overall height, and positioned it under the front seat in the center of the vehicle. The cylinder head was positioned towards the rear end of the front seat and the air cleaner placed above it. This allowed for the shortening of the

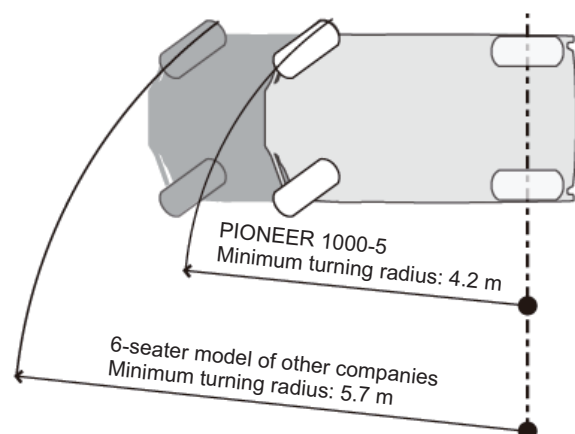


Fig. 21 Turning radius

vehicle's overall length. Also achieved was high ground clearance (327 mm for three-passenger type, 314 mm for five-passenger type) and low center of gravity to improve vehicle stability. Further, the seat height and cargo bed were made low (Fig. 23).

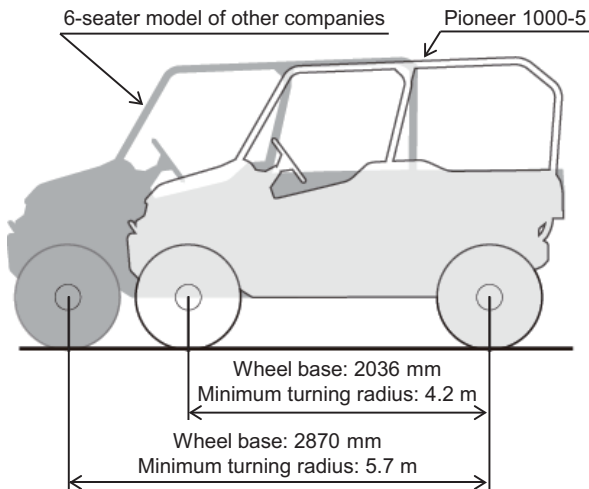


Fig. 22 Comparison of wheel base

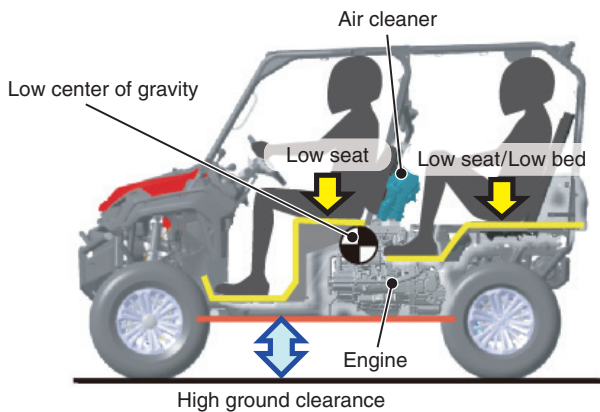


Fig. 23 Location of engine and air cleaner

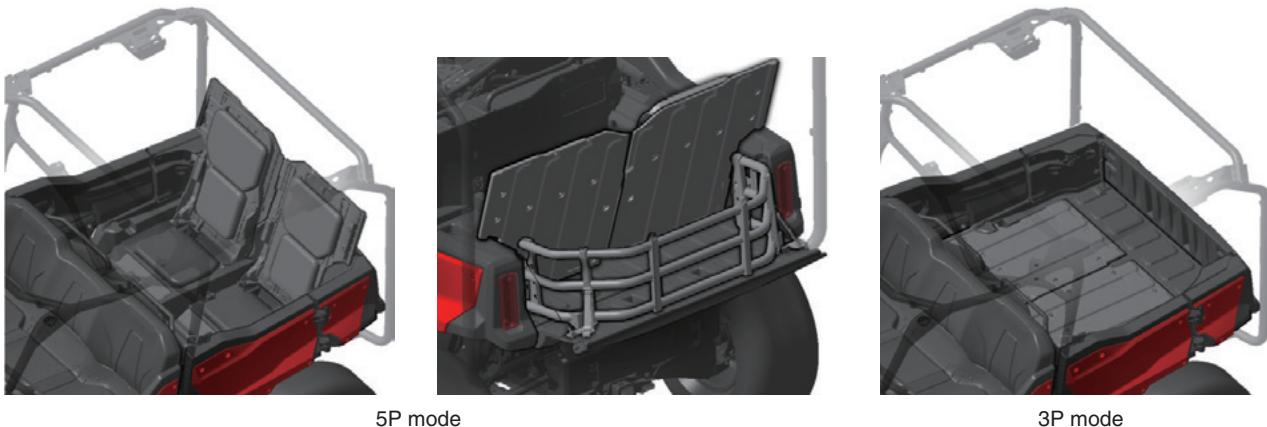
4.1.2. QuickFlip® seat

To solve the issue of a multi-passenger vehicle's tendency to demand a longer vehicle length, for this model we applied QuickFlip® seats to the rear passenger area, a Honda original technology first applied to the PIONEER 700 that allows the rear seatbacks to be folded independently (Fig. 24). The QuickFlip® seat was set to accommodate an AM 95th percentile. Combined with the three seating positions in the front, the model accommodates a total of five passengers. Stowing the seatbacks creates a cargo space having the dimensions of D 1200 mm × W 915 mm (horizontal measurements at the center of loading space). It also retains the ability to tilt the cargo space to dump the load (Fig. 25). The folding and opening of the seats can be done easily and without tools.

With the application of the QuickFlip® seat technology, the cargo space can carry up to 1000 lbs. (454 kg) for practical work. There is also enough capacity in the cargo space behind the seats to accommodate items such as lunch while seating five passengers during recreational use when QuickFlip® seats are expected to be used.



Fig. 25 Dump function



5P mode

3P mode

Fig. 24 QuickFlip® seats

With this, we were able to create a complete vehicle with excellent maneuverability while also securing enough cargo space.

4.1.3. Three-passenger seat in the front row

Vehicle width is often expanded in trying to secure comfortable space for the front-row seat accommodating three passengers at AM 95th percentile. With this model, however, it was required to make the vehicle body compact, with not only a short wheelbase but also a narrower overall width as well. Further, because practical work involves frequent ingress/egress, there was also a need to apply a bench type seat that allows smooth right-left position changes. For these reasons, we developed and applied a three-passenger bench seat. The center seat has the following differences from the adjacent seats: the seat bottom is raised by 18 mm, the hip point is pushed forward by 45 mm, and the seat back is reclined by 4 degrees.

Reclining the center passenger's seat creates a positional offset among the driver and passengers, giving them more shoulder space, making the front row space more practical and comfortable (Fig. 26). Hand-holds were placed on the sides of the center seat for its occupant so as to not block the walk-through path. The bench seat is shaped to better keep occupants in their seats even when in rough driving conditions.

4.2. Quietness Technologies

The targets for quietness were set as follows: allowing occupants to hear each other in conversations up to the speed where wind noise becomes an issue (30 mph); and maximum of 83.5 dB for noise close to the ears at the driver's seat when driving at a cruising speed of 30 mph or below. The intake was placed inside the front hood, further away from the occupants compared to past models, lowering the level of the noise generating in the intake. To mitigate pipe resonance, two resonators were built into the intake duct (Fig. 27). Sound absorbents were also placed to mitigate radiated sounds from the engine and air cleaner box located near the front seat occupants as shown in yellow figure (Fig. 28). Further, when cruising, radiated sound from the engine is suppressed by controlling the DCT shifting timing to keep engine speed low. Through

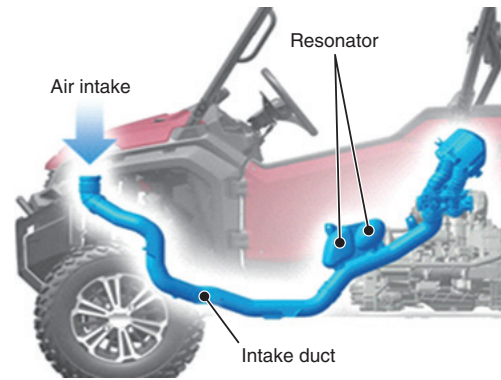
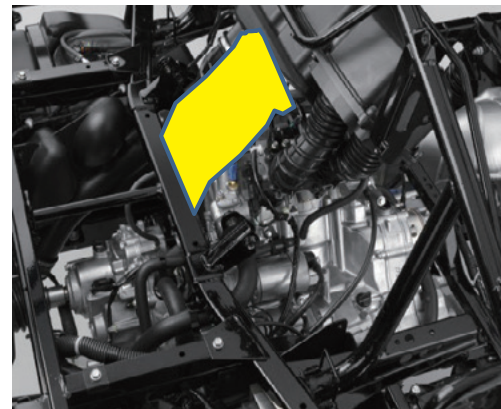
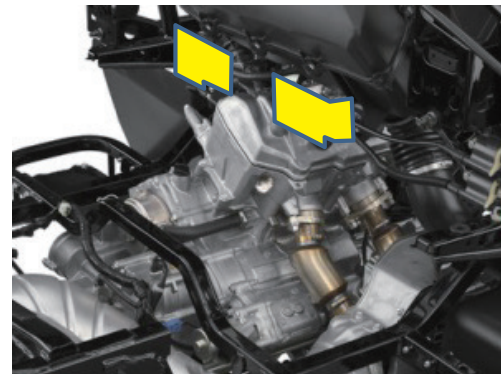


Fig. 27 Intake duct layout



(a) Front side



(b) Rear side

Fig. 28 Noise absorbent location



Fig. 26 Bench type front seat

such technologies the model achieves a level of quietness (Fig. 29) that is advantageous as a flagship model, allowing the occupants to enjoy conversations. Figure 29 shows a comparison of the PIONEER 700.

4.3. Low Vibration Technologies

To mitigate vibration, rubber engine mounts are required due to their effectiveness in damping vibrations at all engine speeds. In particular, when damping vibrations at idle, the spring characteristics need to be greatly reduced compared to those used for previous Honda ATVs and Side by Sides (Fig. 30). As such, we adjusted the spring characteristics on a rubber mount made for a small Honda automobile that has the same engine weight; this resulted in engine vibration mitigation in all ranges, including idling, and realizing a level of vibration that is comfortable for occupants (Fig. 31).

4.4. Intake System

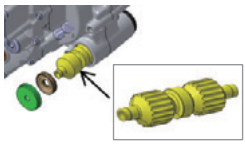
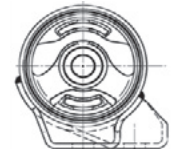
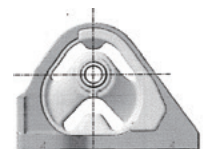
Side by Sides often are used in very dusty off-road conditions. Because plain bearings are used as engine crank shaft bearings in the PIONEER 1000, as compared to the ball bearing equipped engine used in conventional Honda Side by Sides, there was a need to make it more difficult for dust to enter the engine. To accomplish this, for the first time on any Honda Side by Side or ATV, we applied a wet filter paper type air cleaner element that absorbs more dust than the conventional wet urethane type. However, wet filter paper type filters require replacement. The replacement interval was extended by making the air cleaner element's filtering surface area 8 times larger than the washable wet urethane type applied to the PIONEER 700, the previous model. Also, the intake was placed inside the front hood, where dust is less likely to accumulate (Fig. 27). Through these measures, we aimed to reduce the amount of dust that enters into the air cleaner.

4.5. Exhaust System

Gaining high torque from low engine speeds requires

the exhaust pipe to be long. To secure passenger space for the rear passenger seats, the pipe layout was set as shown in Fig. 32. Giving the muffler a capacity suitable for a 1000 cm³ class engine made it heavy, so, with consideration to the right-left weight balance, it was placed in the center of the rear of the vehicle. The exhaust pipe and muffler were joined at a perpendicular angle.

The exhaust system is supported in a way that engine vibrations and vehicle body vibrations, such as jolts coming from road input are mitigated. To enable the system to absorb vibrations from all directions, we applied hanging rubber mounts (Fig. 32) and a spherical joint system

	Mounting rubber shape	Z-direction stiffness comparison with TRX 680
TRX 680		100%
PIONEER 1000		19%
Honda small automobile		19%
PIONEER 700		60%

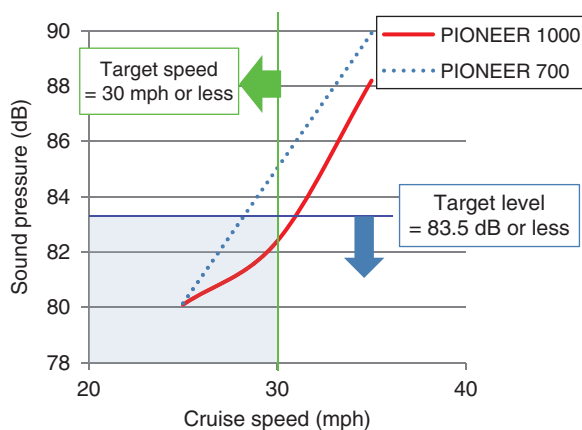


Fig. 29 Cabin noise target and measurement result

Fig. 30 Dynamic spring characteristics and shape

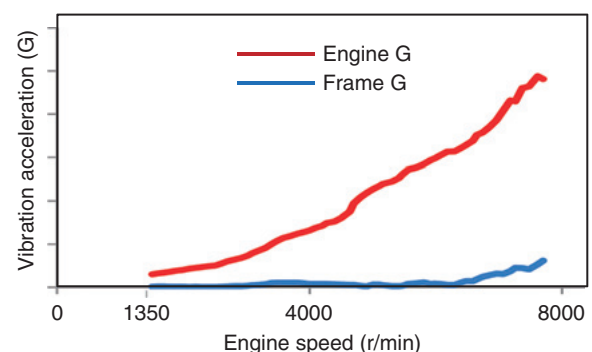


Fig. 31 Vibration mitigation effect

(Fig. 33). Through such measures, the vibrations were mitigated while supporting a heavy muffler with a simple and light-weight method.

4.6. Electrical System

4.6.1. Headlights

The five-passenger deluxe model applies LED headlights, the first for a Honda Side by Side. This gives the model top-in-class brightness while keeping power consumption at only 70% (in low beams) of Honda's conventional light bulbs. To give the feel of brightness to the drivers, the lamps used have the color temperature of 5000 K, which is equivalent to the color temperature of sunlight. Here, 7 direct illumination type LED lights are used to make one lighting body to create an appearance that better embodies the styling concept of "Unstoppable" than using regular light bulbs (Fig. 34, 35).

4.6.2. Multi-function display

The model applies a multi-function display (Fig. 36).

- Tachometer: The layout was designed to allow intuitive manual shifting using the paddle shifter.
- Switching driving powers: By showing the driving condition on the display, it can be immediately understood by the driver.
- DCT shift modes: The two AT modes (AT and Sport)

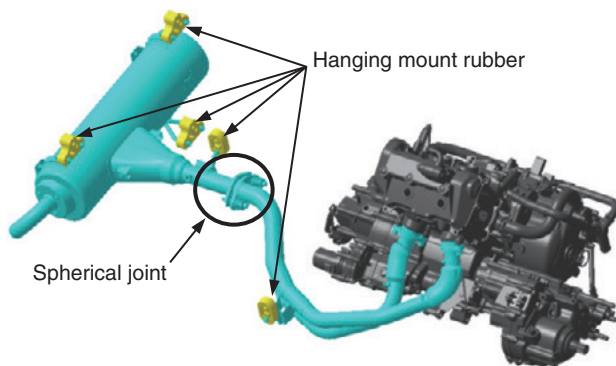


Fig. 32 Exhaust system layout

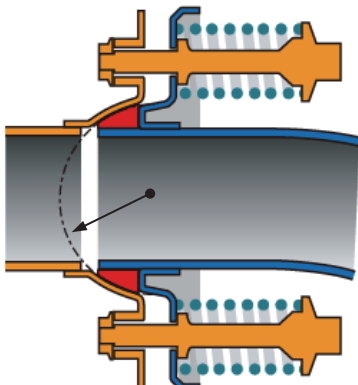


Fig. 33 Spherical joint system

and the MT mode are indicated with individual icons.

In order to make the display easier to see with a Honda Side by Side, a large LCD that is 2.3 times larger than conventional models was applied.

The display was also placed in the center of the cockpit to provide good visibility for a model having improved off-road capabilities. This resulted in the creation of a cockpit with which the driver can further concentrate on driving (Fig. 37).



Fig. 34 LED head lights



Fig. 35 Bulb head lights

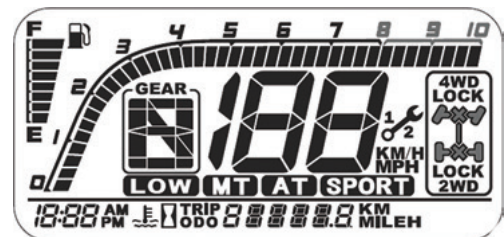


Fig. 36 Multi-function display

4.7. Suspension

A suspension system with excellent drivability on rough roads and ride comfort were applied to this flagship model, with best-in-class wheel travel (front wheel travel of 268 mm or 10.5 in., rear wheel travel of 254 mm or 10 in.). The five-passenger deluxe model applies self-leveling rear cushions made by ZF SACHS. The cushions were applied to overcome the tendency of Side by Sides to sacrifice ride



Fig. 37 Cockpit

comfort due to great changes in vehicle height as cargo weight increases.

In a conventional system, the operator had to manually operate the preload adjusters in the rear cushion springs to change the preload and adjust vehicle height.

For the PIONEER 1000, when the vehicle starts moving after cargo is loaded into the cargo bed, sinking the self-leveling rear suspension, the cushion rods travel vertically and oil is pumped upward from the low-pressure gas chamber to the high-pressure gas chamber. This increases the pressure inside the high-pressure gas chamber and pushes up the piston rods, bringing back the vehicle height to that of a no-load condition (Fig. 38).

By providing a mechanism to automatically adjust the vehicle height regardless of cargo weight or rear-seat passenger loading, all occupants can enjoy a stable drive feel.

4.8. Steering Mechanism

The desire for a more comfortable steering effort in rough trail conditions is increased in Side by Sides. Similarly, and particularly when considering the easy

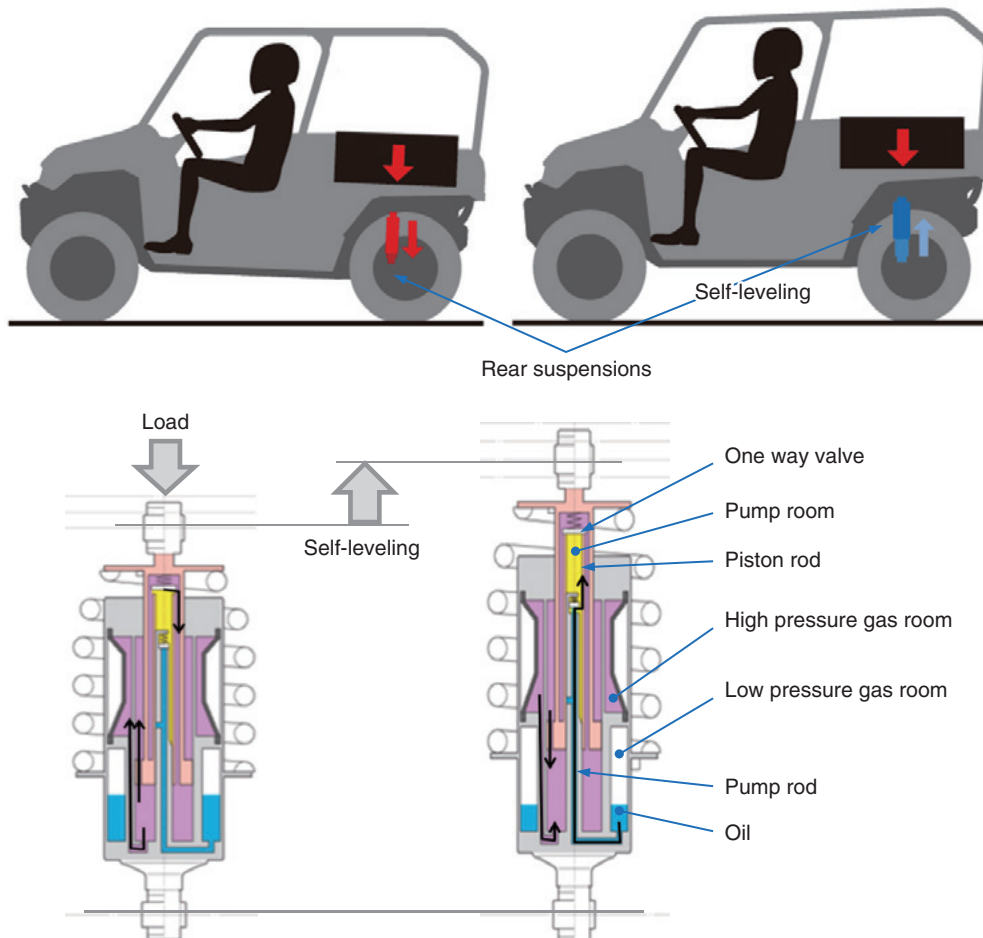


Fig. 38 Self-leveling suspension

maneuverability that is fit for a flagship vehicle, flexibility in driving positions is also desired. For these reasons, this model applies an electric power steering (EPS) and a tilt steering wheel (excluding the three-passenger standard model).

Since Side by Sides are used in conditions that are more severe than those of automobiles, we applied an EPS system for ATVs, which has similar usage conditions, and optimized it by including an assist function and installation method for Side by Side application.

The mechanism was placed in the middle shaft to minimize the likelihood of exposure to water (Fig. 39).

The tilt steering wheel allows for the driver to operate a gas damper lever to easily adjust the angle of the steering wheel to meet their preferences and body type.

Further, to give ease of ingress/egress, the tilt angle of the steering wheel was set at 31 degrees.

It's larger than automobiles.

4.9. Brakes

The model's brake system is based on that of an automobile, with adjustments made in light of the various usage environments. This model in particular required easy and stable braking, while taking into account the likely changes in the number of occupants (from 1 to 5) and the amount of cargo (starting at none). In order to achieve this, 2 piston calipers were applied in the front, a first for a Honda Side by Side (Fig. 40). These front calipers have a small-diameter dust sealing structure originally designed for motorcycle use, to make the body area around the sealing grooves more compact in order to fit inside 12-inch wheels. By making them smaller, the weight of the caliper is reduced by approximately 40% compared to automotive use calipers that previously have been applied to Side by Sides. Applying 2 piston calipers also expanded the discs' effective radius by 10%, improving braking performance

(Fig. 41). The single-piston rear calipers were also made more compact, and the piston size was changed while considering the front/rear braking balance. As a result, we were able to give this model good braking performance in various cargo load conditions, a well-balanced front/rear braking force distribution, and ease of control. For durability, the newly developed calipers have caliper brackets shaped so as to prevent damage to piston surface due to mud and chipping.



Fig. 40 Front brake

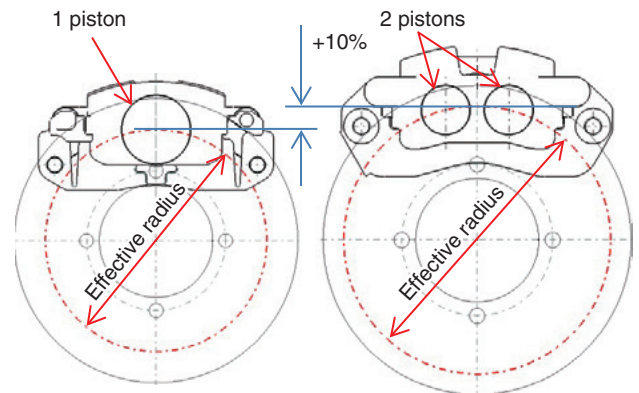


Fig. 41 Front disc effective radius

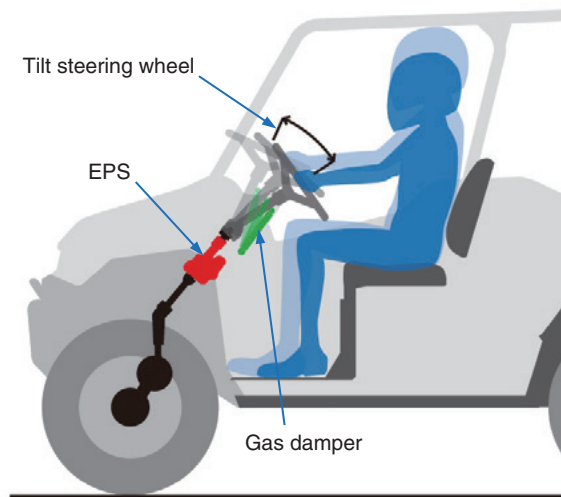


Fig. 39 EPS

5. Styling Design

5.1. Styling Concept

To embody the model's concept of "King of Works Hard, Plays Hard," the following three keywords were set for the styling concept.

Rugged: Durability that withstand tough use

Versatile: Versatility to be used for work and play

Unstoppable: A force that cannot be stopped

We also targeted to give the model an appearance that suggests a sense of continuity by styling the front mask to be immediately recognizable as being a part of the PIONEER family.

5.2. Method of Achieving the Styling

We first focused on clearly conveying the above three keywords.

The feel of force was achieved with the rugged shaping that exudes an air of toughness, proportions with a strong and functional stance of a four-by-four, and a bumper and front grill (Fig. 42) shaped in an aggressive design with vigorousness, resulting in embodying the model concept of “King of Works Hard, Plays Hard.”

To also make the model immediately recognizable from afar, dynamically shaped colored panels were applied in a continuous manner on the body sides (Fig. 43).

As a result, we created a styling design that beautifully balances the functionality that satisfies the pride of the customers for owning a flagship model and its exciting recreational capabilities.

5.3. Digital Modeling

In this development, modeling was done digitally using the 3D-CAD technology (Fig. 44) and without clay models. Simple, life-size models were used to confirm the feel of the size and ergonomics, and large-screen virtual reality displays were used to verify the styling and color appearances.

Using the 3D-CAD technology, it was possible to reflect data obtained through CAE analyses such as aerodynamics, strength and the dimensions of the movable areas such as tire clearances to digital models at high resolutions, thus enabling us to give the model a high level of both styling and functions. As a result, we were able to create a highly precise appearance within a short period of time.

In this development, we utilized these methods to create a styling design that well expresses the “King of Works Hard Plays Hard” concept.



Fig. 44 Styling design using a digital model



Fig. 42 Aggressive front grill



Fig. 43 Colored panels applied to body sides

6. Conclusion

PIONEER 1000 was developed with the aim to “offer both recreational and work capabilities,” “have the power performance, drivability on rough roads, and good ride comfort at a level suitable for a flagship,” and “be a multi-passenger vehicle model that people can enjoy with family and friends with a maneuverable vehicle size.” It applies a new two cylinder 999 cm³ engine and an industry-first 6-speed DCT with an High/Low sub-transmission with excellent transmission efficiency and durability, and the QuickFlip® seat for the five-passenger models, earning itself the title of a flagship. Many new technologies were applied as well, including low-vibration technologies and the self-leveling suspension to further improve comfort. These efforts resulted in the creation of a class-leading flagship model following PIONEER 500 and PIONEER 700 in Honda’s multi-category Side by Side series, with two passenger capacity settings (3 and 5). With PIONEER 1000, anyone can enjoy off-road driving, from first-time off-road drivers to the more experienced and skilled. It enables the drivers to share the joy of recreational uses with a larger group of friends and family as well as offering practical work capabilities that are among the best in the class. It is our hope that PIONEER 1000 will be popular in the market as a model that works hard, plays hard.

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